

---

## Chapter 3

# The Construction of S&E Research Space

## Highlights . . .

- ◆ In fiscal years 1994-1995, research-performing institutions constructed 9.5 million net assignable square feet (NASF) of science and engineering (S&E) research space. This space was less than that constructed in the 1992-1993 fiscal years, when 12.4 million NASF of S&E research space were constructed, and less than that constructed in any other period since the National Science Foundation began collecting data on S&E research facilities.
- ◆ Research-performing institutions spent \$2.8 billion to construct S&E research space in fiscal years 1994-1995, a decline of \$272 million since 1992-1993. This decline in the amount of space constructed and the amount of dollars spent to construct space occurred in both types of doctorate-granting institutions, but did not occur in nondoctorate-granting institutions.
- ◆ Engineering, the medical sciences in medical schools, and the physical sciences accounted for more than half of the \$2.8 billion in construction spending by research-performing institutions in fiscal years 1994-1995.
- ◆ For fiscal years 1996-1997, research-performing institutions were scheduled to spend \$3.1 billion to construct S&E research space and another \$245 million to construct central campus infrastructure.

---

## Background

In 1994, the National Science Foundation noted the first declines in spending for construction since data collection on S&E research facilities began in 1986 (National Science Foundation, 1994). Reductions in spending on higher education on the part of both Federal and state governments in the early 1990s followed a period when many colleges and universities had deferred maintenance on their buildings. At the same time, changes in technology altered the ways scientists and engineers now conduct research and train students, generating a need for new laboratories and additional research space.

What follows is a discussion of the current state of construction for S&E research in research-performing colleges and universities, the object being to determine whether the declines in construction spending noted in 1994 have continued to drop.

## The Survey Questions

Institutions were asked to estimate the research-related costs and space for construction projects begun during fiscal years 1994-1995, and to make the same estimates for projects scheduled for fiscal years 1996-1997. Project start-up was defined as the fiscal year in which construction began or was expected to begin. In the case of multiyear projects, total project costs were allocated to the fiscal year in which the construction began.

The reported costs, defined as the costs to complete a project, included planning, site preparation, construction, fixed equipment, non-fixed equipment costing \$1 million or more, and building infrastructure. If a project was to serve both research and nonresearch purposes, respondents were asked to prorate the construction costs and space estimates so that the research-related portion of the costs was reflected (see Items 4a and 4b of the survey in Appendix C).

Institutions were also asked to report planned expenditures for central campus infrastructure (see Item 6 of the survey in Appendix C). Central campus infrastructure was defined as those systems that exist between the buildings of a campus and the nonarchitectural elements of campus design. Examples included central wiring for telecommunications systems, waste storage and disposal facilities, electrical wiring between buildings, central heating and air exchange systems, drains, sewers, roadways, walkways and parking systems. Plumbing, lighting, wiring, air exchange systems and the like that exist within a building or within five

---

feet of the building foundation were considered building infrastructure and were excluded from this definition of central campus infrastructure.

## Data Considerations

Data presented below reflect the extent of construction underway in fiscal years 1994-1995. Tables that report expenditures or costs over time are presented in constant dollars, with current-dollar tables found in Appendix F. Constant dollars are inflation-adjusted dollars and compensate for variations in the purchasing power of the dollar over time.

The specific deflator used in this report is the Bureau of the Census Composite Fixed-Weighted Price Index for Construction, which tracks inflation within the construction industry more closely than does a general index. The fixed-weighted price index reflects changes in prices, and remains unaffected by changes in the mix of construction projects during any given year (see Appendix A, "Technical Notes," for further discussion of the price index).

The 1994 report presented trends in 1993 constant dollars, and was the first time constant dollars were used in any of the biennial NSF facilities reports. This report adjusts dollar figures to 1995 constant dollars. Thus, constant dollar figures in the 1994 and 1996 reports cannot be compared directly.

The term "construction" in this chapter and throughout this report refers to building facilities that currently do not exist.

It also should be noted that changes in construction spending from one year to another can result from projects at a small number of institutions. Given the costs of constructing S&E research facilities, a large increase could reflect a new building on one or two campuses. We note these situations when appropriate.

## Findings

### How Much S&E Research Space Did Institutions Construct?

Between the 1986-1987 and the 1992-1993 fiscal years, the overall amount of S&E research space constructed by research-performing colleges and universities increased. This aggregate trend did not continue, however, between the 1992-1993

and 1994-1995 fiscal years. In 1992-1993, research-performing institutions constructed over 12.4 million NASF of S&E research space. In 1994-1995, the amount under construction dropped to 9.5 million NASF, a total less than any other period since the National Science Foundation began collecting data on S&E research facilities<sup>3</sup> (Table 3-1).

**Table 3-1. Trends in net assignable square feet (NASF) of science and engineering (S&E) research space under construction by institution type: 1986-1995**  
[NASF in thousands]

<i>Institution type</i>	<i>1986-1987</i>	<i>1988-1989</i>	<i>1990-1991</i>	<i>1992-1993</i>	<i>1994-1995</i>
<b>Total</b>	9,922	10,647	11,433	12,405	9,521
Doctorate-granting	8,908	9,840	11,022	12,014	8,818
Top 100 in research expenditures	7,261	6,073	6,972	8,197	6,426
Other	1,647	3,767	4,050	3,818	2,391
Nondoctorate-granting	1,014	807	411	391	703

*SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.*

Of interest are the differences between research-performing, doctorate-granting universities and nondoctorate-granting institutions. Among doctorate-granting universities, the amount of NASF constructed declined from 12 million NASF to 8.8 million NASF between fiscal years 1992-1993 and 1994-1995, a decrease of approximately 32 percent. The amount of construction at the top 100 institutions dropped less, in relative terms (22 percent), than did the amount at other doctorate-granting institutions (37 percent).

The amount of construction at nondoctorate-granting institutions increased for the first time between the 1992-1993 and 1994-1995 fiscal years, from 391,000 NASF to 703,000 NASF. This increase resulted from large construction projects at a few institutions.

<sup>3</sup> Although the amount of S&E research space under construction declined between fiscal years 1992-1993 and 1994-1995, the total amount of S&E research space continued to increase over this period (see Table 1-4). There are a number of ways the amount of S&E research space can increase without the addition of newly constructed facilities. Space used for instruction or other purposes, for example, can be converted into research space. Also, the definition of research used in this survey limits space to that which supports research activities that are budgeted and accounted for. Thus, space might exist in a given survey cycle, but if it did not support funded research activities, it should not be included in the space reported in question 1.

## How Much did Institutions Spend on the Construction of S&E Research Space?

Consistent with trends in the amount of S&E research space constructed, total construction expenditures declined between the 1992-1993 and 1994-1995 fiscal years, in constant dollar terms. However, construction spending actually began to decrease before the decrease in the amount of space being constructed. The first decrease in construction spending occurred between the 1990-1991 and 1992-1993 fiscal years (Table 3-2). This incongruity between trends in the amount of S&E research space constructed and construction expenditures could reflect widely varying construction costs--costs that are affected by the S&E field in which space is constructed, the complexity of the research space, and geographic location.

In fiscal years 1994-1995, total expenditures for S&E research space construction projects in research-performing institutions totaled \$2.8 billion, a decline of \$272 million in constant dollars from fiscal years 1992-1993. This decline in expenditures for constructing S&E research space represents a continuation of a trend that began between fiscal years 1990-1991 and 1992-1993. In constant dollar terms, construction spending declined \$313 million between those fiscal years (Table 3-2 and Figure 3-1).

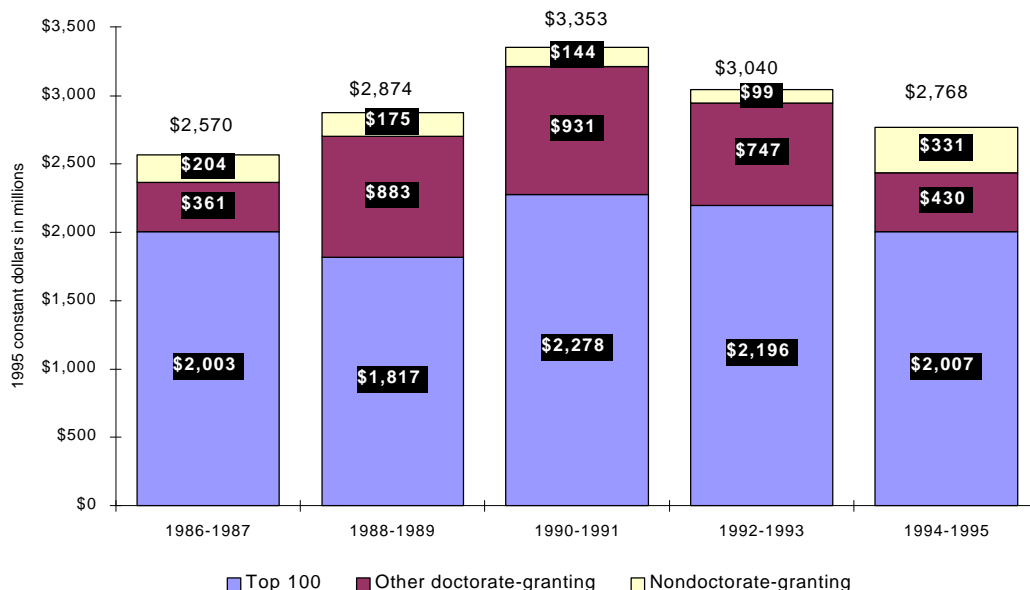
**Table 3-2. Trends in expenditures to construct science and engineering (S&E)  
research facilities by institution type: 1986-1995**  
[Constant 1995 dollars in millions]<sup>1</sup>

<i>Institution type</i>	<i>1986-1987</i>	<i>1988-1989</i>	<i>1990-1991</i>	<i>1992-1993</i>	<i>1994-1995</i>
<b>Total</b>	\$2,570	\$2,874	\$3,353	\$3,040	\$2,768
Doctorate-granting	2,365	2,700	3,207	2,940	2,437
Top 100 in research expenditures	2,003	1,817	2,278	2,193	2,007
Other	361	883	931	747	430
Nondoctorate-granting	204	175	144	99	331

<sup>1</sup> Current dollars have been adjusted to 1995 constant dollars using the Bureau of the Census's Composite Fixed-Weighted Price Index for Construction.

*SOURCE:* National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Figure 3-1. Trends in S&E Construction Expenditures, by Institution Type: 1986-1995



SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Both types of doctorate-granting institutions experienced decreases in construction spending in 1995 constant dollar terms. Nondoctorate-granting institutions experienced an increase of \$232 million during fiscal years 1994-1995, compared to fiscal years 1992-1993. The other doctorate-granting institutions had the largest decline in construction spending for S&E research space between fiscal years 1992-1993 and 1994-1995, from \$747 million to \$430 million in constant dollar terms (a 42 percent decline).

## How Much Did Institutions Spend on the Construction of S&E Research Space in Different Fields?

Engineering, the medical sciences in medical schools, and the physical sciences accounted for more than one-half of the \$2.8 billion in construction spending by research-performing institutions in fiscal years 1994-1995 (Table 3-3). Academic institutions spent \$575 million to construct engineering research space, \$525 million for research space in the medical sciences in medical schools, and \$426 million for research space in the physical sciences.

**Table 3-3. Trends in expenditures for capital projects to construct science and engineering (S&E) research facilities by field: 1986-1997**  
[Constant 1995 dollars in millions]<sup>1</sup>

<i>Field</i>	<i>1986-1987</i>	<i>1988-1989</i>	<i>1990-1991</i>	<i>1992-1993</i>	<i>1994-1995</i>	<i>1996-1997 (scheduled)</i>
<b>Total</b>	\$2,570	\$2,874	\$3,353	\$3,040	\$2,768	\$3,072
Biological sciences-- outside medical school	406	462	508	316	388	507
Physical sciences	228	468	484	364	426	390
Psychology	29	29	41 <sup>2</sup>	17	42	38
Social sciences	48	56		48	112	54
Mathematics	2	10	14	11	2	25
Computer sciences	77	76	45	51	46	31
Earth, atmospheric, and ocean sciences	71	95	191	133	33	240
Engineering	538	453	445	309	575	429
Agricultural sciences	188	177	197	227	150	212
Medical sciences-- outside medical school	254	71	170	173	122	243
Medical sciences-- medical school	378	684	738	907	525	672
Biological sciences-- medical school	174	211	429	369	226	214
Other	174	82	90	111	122	16

<sup>1</sup> Current dollars have been adjusted to 1995 constant dollars using the Bureau of the Census's Composite Fixed-Weighted Price Index for Construction.

<sup>2</sup> Psychology and social sciences were not differentiated in the questionnaire item for the 1990-1991 period.

*SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.*

Institutions spent the next largest amounts of money to construct research space in the biological sciences outside of medical schools (\$388 million), the biological sciences in medical schools (\$226 million), and the agricultural sciences (\$150 million). The largest increase in spending for the construction of S&E research space between fiscal years 1992-1993 and 1994-1995 occurred in engineering, which leaped from \$309 million to \$575 million.

Most fields experienced a decrease in construction spending between fiscal years 1992-1993 and 1994-1995. After its relatively high level of funding in 1994-1995, spending to construct medical science research space in medical schools decreased by \$382 million, from \$907 million in fiscal years 1992-1993, to \$525 million in 1994-1995. Funding in the biological sciences in medical schools also fell steeply, from \$369 million in 1992-1993 to \$226 million in 1994-1995. Funding for research space in the earth, atmospheric, and ocean sciences declined from \$133 million to \$33 million during the same period.

## How Much Were Institutions Scheduled to Spend on the Construction of S&E Research Space and on Central Campus Infrastructure?

For fiscal years 1996-1997, research-performing institutions were scheduled to spend \$3.1 billion to construct S&E research space. If all of this construction were to occur, it would represent an increase of \$304 million over the amount actually spent on construction, \$2.8 billion, in the 1994-1995 fiscal years.<sup>4</sup>

This increase is not, however, uniform across different types of research-performing institutions. Nondoctorate-granting institutions expected a decline in construction spending in 1996-1997, from a high of \$331 million in 1994-1995 (Table 3-2) to \$264 million over the next two fiscal years.

**Table 3-4. Scheduled construction expenditures for science and engineering (S&E) research space and central campus infrastructure by institution type: 1996-1997 (Dollars in millions)**

<i>Institution type</i>	<i>Scheduled Construction</i>		
	<i>S&amp;E Research Space</i>	<i>Central Campus Infrastructure</i>	<i>Total</i>
<b>Total</b>	\$3,072	\$245	\$3,317
Doctorate-granting	2,807	228	3,035
Top 100 in research expenditures	2,104	187	2,291
Other	704	41	745
Nondoctorate-granting	264	18	282

SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

<sup>4</sup> It should be noted, however, that doctorate-granting universities generally do not spend on the construction of S&E research space as much as they report planning to spend. Nondoctorate-granting institutions, on the other hand, typically spend more than they plan to.



---

Research-performing institutions were scheduled to spend another \$245 million to construct central campus infrastructure space (Table 3-4).<sup>5</sup> Ninety-three percent of the expenditures on infrastructure space--\$228 million--was scheduled for construction at doctorate-granting universities. Only 7 percent was scheduled at nondoctorate-granting institutions.

It should be noted that increases in scheduled construction varied by S&E field. The largest increases were scheduled for the earth, atmospheric, and ocean sciences, from \$33 million in 1994-1995 to \$240 million in 1996-1997; mathematics, from \$2 million to \$25 million; agricultural sciences, from \$150 million to \$212 million; biological sciences outside of medical schools, from \$388 million to \$507 million; and medical sciences outside of medical schools, from \$122 million to \$243 million (Table 3-3).

### To What Extent Were Colleges and Universities Involved in Constructing S&E Research Space?

Consistent with the decline in both the amount of space being constructed and construction expenditures for S&E research space at the doctorate-granting institutions, the percentage of institutions undertaking construction projects declined. In 1992-1993, 44 percent of all doctorate-granting universities reported S&E research construction (Table 3-5); for the 1994-1995 fiscal years, 42 percent reported construction.

---

<sup>5</sup> Questions regarding the construction of central campus infrastructure space were not included in the 1994 survey.

**Table 3-5. Trends in the percentage of institutions starting capital projects to construct science and engineering (S&E) research facilities by institution type: 1986-1997**

<i>Institution type</i>	<i>1986-1987</i>	<i>1988-1989</i>	<i>1990-1991</i>	<i>1992-1993</i>	<i>1994-1995</i>	<i>1996-1997 (scheduled)</i>
<b>Total</b>	37%	44%	37%	33%	29%	29%
Doctorate-granting	47	53	57	44	42	40
Top 100 in research expenditures	72	71	81	79	75	64
Other	34	44	45	28	26	29
Nondoctorate-granting	25	32	12	15	13	13

NOTE: As used here, capital projects are construction projects with prorated costs of \$100,000 or more for affected research space. Percentages are based on the number of institutions with some science and engineering research space.

SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Like the doctorate-granting institutions, the percentage of nondoctorate institutions reporting S&E research construction activity dropped slightly, from 15 percent in 1992-1993, to 13 percent in 1994-1995, despite the increase in construction space and expenditures in nondoctorate-granting institutions. Once again, these figures reflect the large scope of construction projects undertaken by relatively few nondoctorate-granting institutions in 1994-1995.

For the next two fiscal years, 1996-1997, 29 percent of all research-performing institutions reported that they were scheduled to undertake S&E research construction projects (the same percentage of institutions involved in construction in 1994-1995). Fewer top 100 institutions, however, indicated they had construction projects scheduled than actually occurred in previous years. Only 64 percent of those universities reported scheduled construction.

## In What Fields Were Construction Projects Undertaken?

Since fiscal years 1986-1987, construction projects have been more likely to occur in some S&E fields than in others. During fiscal years 1994-1995, approximately one-fourth (24 percent) of the institutions with medical schools began construction projects for the medical sciences (Table 3-6). Twenty-one percent of the research-performing institutions with agricultural science research space and 15 percent of those with engineering research space started capital projects during the same period. Other S&E fields in which capital projects were begun included the physical sciences and the biological sciences within medical schools (10 percent each).

**Table 3-6. Trends in the percentage of institutions starting projects to construct science and engineering (S&E) research facilities by field: 1986-1997**

<i>Field</i>	<i>1986-1987</i>	<i>1988-1989</i>	<i>1990-1991</i>	<i>1992-1993</i>	<i>1994-1995</i>	<i>1996-1997 (scheduled)</i>
<b>Total</b>	37%	44%	37%	33%	29%	29%
Biological sciences-- outside medical school	9	19	10	10	8	10
Physical sciences	9	15	11	9	10	11
Psychology	5	3	7 <sup>1</sup>	2	2	1
Social sciences	5	4		3	4	3
Mathematics	1	2	4	2	1	1
Computer sciences	8	6	7	4	2	2
Earth, atmospheric, and ocean sciences	9	6	15	9	5	5
Engineering	28	18	16	17	15	10
Agricultural sciences	38	33	30	27	21	24
Medical sciences-- outside medical school	7	5	13	11	6	8
Medical sciences-- medical school	32	23	41	33	24	25
Biological sciences-- medical school	20	26	33	20	10	11

<sup>1</sup> Psychology and social sciences were not differentiated in the questionnaire item for the 1990-1991 period.

*SOURCE: National Science Foundation/SRS, 1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.*